

# Program Structure

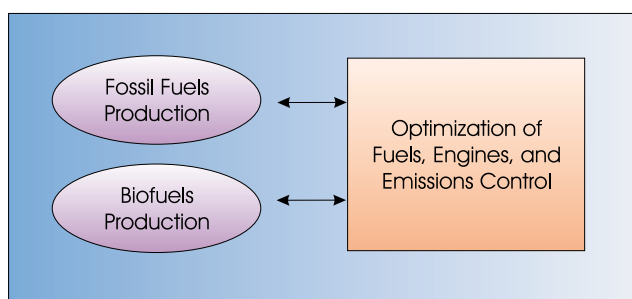
The Ultra Clean Transportation Fuels Program is structured to capitalize on DOE's strengths in resolving the issues of the highway transportation sector, to result in increasing energy security (e.g., increasing domestic production and resource diversification), thereby reducing emissions and minimizing greenhouse gases.

The Program features near-term options that are inclusive of petroleum, and consider alternative fuels (derived from natural gas, coal, and renewable feedstocks), as candidate blending stocks for petroleum-based fuels. Longer-term options include alternative neat fuels derived from non-petroleum, fossil, and biomass feedstocks.

The Program includes three major functions: fossil fuels production, biofuels production, and optimization of fuels, engines, and emissions control (see Figure 5). The goals of the functions are to:

- Produce petroleum-based ultra-clean fuels.
- Produce ultra-clean, non-petroleum, fossil-based fuels for use as blending stocks in the near term to mid term and potentially as neat fuels in the long term.
- Develop advanced refinery processes and innovative fuel-making components, materials, and technologies.
- Produce ultra-clean biofuels for use as a blending stock for petroleum-based fuels in the near term and as a neat fuel in the long term.
- Optimize fuels-sensitive engine and emissions control components through iterative testing and refinement.
- Component optimization will be coordinated with existing emissions control R&D programs.
- The Program recognizes that events, domestic and international, require that its schedule for technology development be shortened and its objectives achieved at an accelerated rate. The Program Plan integrates the associated supporting activities ongoing in the Office of Fossil Energy and Office of Energy Efficiency and Renewable Energy.
- Each of the three major program functions is described in the following pages.

Figure 5: Three Major Functions of the UCTF Program



# Program Elements

## Fossil Fuels Production

### Goal

The goal of this program function is to promote the development of technologies that will ensure the availability of the Nation's fossil fuel resources for production of a stable supply of clean and affordable transportation fuels. These fuels will be cost-competitive while addressing global and domestic challenges. Public/private partnerships will be achieved with the refining and transportation industries to promote the development and deployment of technologies to produce ultra-clean, high-performance transportation fuels from all fossil energy resources. These fuels will enable the introduction of advanced, high-efficiency fuel/engine/emissions control combinations. Resource diversity will be promoted that will result in fossil feedstocks other than petroleum being used to produce ultra-clean fuels, thereby reducing our dependence on imported petroleum. These ultra-clean liquid fuels will use the Nation's existing fuel transportation infrastructure.

### R&D Challenges

Meeting the demand of 12–15 million barrels per day of ultra-clean vehicle fuels will require technologies that can achieve near-complete removal of emission precursors at reasonable cost from a full suite of fossil feedstocks. These fossil feedstocks include high-sulfur crude, refinery bottoms, natural gas and coal, as well as high-value, low-sulfur, sweet crude resources that are

being rapidly depleted. Improved techniques for synthesis gas and hydrogen production, and synthesis gas conversion to premium products are needed. New processes must be invented, verified, demonstrated, and deployed, and the quality of the product confirmed.

### R&D Initiative

These new fossil fuels production activities will build on the fundamental research (particularly the catalyst and reactor development effort) being conducted in the Petroleum Processing, Gas-to-Liquids, and Coal-based Transportation Fuels Programs that have clean fuels development as their primary goal. These programs will be coordinated and integrated to implement the UCTF Program in the most efficient and cost-effective manner.

The activities in this function will concentrate on developing options for the near, mid, and long range. In the near term, industry/government projects will demonstrate advanced petroleum-based fuel-making processes at pre-commercial scale, generating sufficient advanced fuels to enable fuel/engine/emissions control verification testing. The mid-to-longer term activities will be concerned with the economic production and utilization of feedstocks such as natural gas, petroleum coke, heavy hydrocarbon bottoms, and coal.



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## Biofuels Production

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### Goal

The goal of this program function is to foster the development of a domestic biofuels industry through RD&D activities in partnership with industry, universities, other Federal agencies, and state/local governments.

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### R&D Challenges

The cellulose in wood, agricultural residues, and other biomass can be hydrolyzed into sugars for subsequent fermentation into ethanol fuel. This hydrolysis process must be made less costly through innovative biomass pretreatment techniques and efficient enzymes. Next generation fermenting micro-organisms need to be more robust and versatile to achieve low-cost fermentation of multiple sugars into ethanol. While agriculture residues are an important source of feedstock for the near term and mid term, energy crops (specialized, fast growing grasses and trees) will ensure an abundant feedstock supply in the long term when biofuels would be widely used. The yields per acre and resistance to diseases and drought for such crops need to be improved to support a major biofuels industry. Harvesting, handling, and storage of biomass need additional development and demonstration to reduce time and manpower requirements.

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### R&D Initiative

DOE, industry, and leading universities are collaborating on R&D focusing on enzymes, biomass pretreatment, and fermenting micro-organisms, including genetically engineered yeasts and bacteria. Feedstock R&D involves close collaboration with the U.S. Department of Agriculture (USDA), the forestry industry, farmer organizations, and universities. Industry/Federal agencies/state and/or local government partnerships will demonstrate ethanol production technologies at commercial scale. The Bioenergy Initiative embodies increased coordination with industry, agricultural interests, other DOE programs, USDA, and various public sector organizations. The Biofuels Production Program function is developing a variety of biomass ethanol production technologies for use at: (1) at corn ethanol plants for converting their abundant corn harvesting residues into ethanol; (2) municipal solid waste facilities for converting the organic components of their waste into ethanol; (3) biomass power plants for producing electricity and ethanol using forest residues; and (4) future integrated biomass processing plants for producing a variety of products including ethanol, electricity, and industrial chemicals. DOE and its partners also will develop improved, high yielding energy crops and demonstrate their deployment in a manner consistent with environmental sustainability principles.



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## Optimization of Fuels, Engines, and Emissions Control

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### Goal

The goal of this program function is to optimize the combined performance of fuels, advanced high-efficiency engines, and emissions control systems to meet Federal light-duty and projected heavy-duty emissions standards.

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### R&D Challenges

Diesel powered light- and heavy-duty vehicles face major challenges in meeting Federal nitrogen oxide and particulate matter emissions standards. The technology development pathway involves determining the changes necessary in fuels and lubricants to enable advanced, high-efficiency engine and emissions control systems to reduce emissions dramatically over the useful life of vehicles. Optimization of a complete system also involves changes to engine and emissions control devices in order to maximize system performance.

The fuels-related fuel cell challenges are to obtain high efficiency, quick start-up, and required catalyst durability utilizing advanced ultra-clean fuels that can be made by U.S. refineries and can use the existing highway transportation fuel infrastructure with minimal impact.

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### R&D Initiative

DOE will partner with the fuels industry, and automotive, engine, and emissions control manufacturers to evaluate and optimize systems to

meet the vehicle emission standards and fuel economy goals. Ultimately, the integrated fuels, engine, and emissions control system will be validated by vehicle testing.

Diesel fuel sulfur effects on nitrogen oxide catalysts and particulate traps will be determined. The appropriate sulfur level must be compatible with required conversion efficiency and durability targets. In addition, fuel sensitive engine and emissions control components, such as specialized fuel injectors, will be developed and tested. Also, improved fuel additives (e.g., oxygenates) and lubricant formulations will be identified to minimize particulate emissions.

DOE will partner with the fuels industry, automotive manufacturers, and fuel cell developers to evaluate and identify optimal ultra-clean fuels for on-board vehicle fuel processors. On-board methods, to remove sulfur and define the tolerance of both fuel processors and fuel cells to fuel sulfur content, will be explored. Effects of various impurities and gasoline constituents (e.g., detergents, antioxidants, etc.) on fuel processor performance and durability will be investigated. In addition, the effects of fuel components (e.g., isooctane, toluene, etc.) on fuel processor efficiency and on catalyst activity and durability will be determined.

Safety, environmental, and cost analyses will be conducted to determine the feasibility of integrating ultra-clean fuels with advanced vehicle technologies in order to achieve the desired results.